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Chapter 1

Background of the Workshop

1.1 Introduction

The age of space research spans only 30 years, yet even in such a short period the progress of solar-terrestrial science can be divided into three major epochs of development. During the 1960s abundant opportunities for space flight led to rapid exploration and characterization of the Earth's outer atmosphere and ionospheric plasma envelope. The terrestrial radiation belts were detected and explained. The boundary between the terrestrial magnetic field and the interplanetary solar wind was discovered. Space observations of the ultraviolet and x-ray portions of the solar spectrum led to an appreciation of the complex processes present in the solar atmosphere. It was during this same era that the processes underlying previously postulated sun-Earth radiative and particle couplings were established with certainty. It was also a time when various satellite missions were defined and quickly developed. Late in the decade, the Apollo missions to the moon provided the opportunity for measurements of the solar wind and the interplanetary magnetic field from temporary lunar bases.

The fruits of planning and knowledge gained from the 1960s were harvested in the 1970s. Many significant atmospheric, ionospheric, magnetospheric, and solar measurements were made with balloons, rockets, and satellites. The concept of pervasive couplings between Earth's upper atmosphere, ionosphere, and magnetosphere emerged and was verified by experiments investigating some of these complex interactions. Skylab, the offspring of a more ambitious space station program, provided rapid response, high resolution images and spectra of flares and other dynamic solar processes. The 1970s also saw the development of National Space Transportation System with its space shuttle.

Solar-terrestrial science of the 1980s has progressed at a more measured pace than in the preceeding two decades. This has resulted from various influences, from: (a) the increasing costs for more complex and sophisticated payloads, (b) a slowly growing national space research budget, and (c) the increasing competition between scientific disciplines for space platforms. These factors, acting in concert, resulted in a significant reduction in the number of flight opportunities for solar-terrestrial science as compared with the earlier two epochs. Small ventures proved difficult to inaugurate, intramural competition for new flight programs became intense, and the time between major flight programs was lengthened. Nevertheless researchers created new models and computer simulations of the Earth's space environment. Noteworthy missions include the Solar Maximum Mission, the Dynamics Explorer satellites, Active Magnetospheric Particle Tracer Explorer (AMPTE) and Charge Composition Explorer (CCE), and the recently flown San Marco satellite. NASA's Theory Program also provided a new means for interpreting space data in terms of global, interactive processes.

Two shuttle-borne Spacelab missions devoted largely to solar-terrestrial science were launched before the Challenger accident in January 1986. These have demonstrated both the strengths and the weaknesses of the shuttle as a platform for scientific experiments. The Challenger accident, however, caused a succession of cancelled shuttle flights and ripple-down delays in the initiation of major, new flight programs which affected the entire solar-terrestrial research community. The long-term effects of the accident will be seen for a significant part of the next decade, and science advisory bodies to NASA have explored the situation in the important report from the Space and Earth Sciences Advisory Committee, "Crisis in Space Science."

Yet, even with this discouraging turn of events, the NASA program for near-term space flights devoted to solar-terrestrial science has developed with surprising vigor. A list of currently operating and near-term missions under development for the next 5 years is given in Table 1. From this, it appears that the needs of

Table 1. Current NASA Program in Solar-Terrestrial Science

Operating	Near Term	In Planning
Solar Processes		
SMM	Max-91	OSL
Rockets (5/year)	Solar-A	Solar Probe
	SOHO	Rockets (7/year)
	Rockets (5/year)	Space Station Attached Payloads
		Explorers (ACE)
		Small Explorers
Geospace System		
IMP	CRRES	EOS
DE	UARS	Space Station
AMPTE/CCE	ATLAS-1, 2, 3	Attached Payloads
San Marco	Geotail	IKI-Equator
Rockets (15/year)	Wind	Rockets (18/year)
	Polar	Explorers (Melter)
	Cluster	Small Explorers
	Rockets (15/year)	
Active Plasma Experiments		
Rockets (5/year)	ACTIVE, APEX (USSR)	EOS Platform
	CRRES	Space Station Attached Payloads
	ATLAS-1, 2, 3	Rockets (7/year)
	TSS-1	Small Explorers
	Rockets (5/year)	

the research community for a variety of space measurements will be at least partially met with a combination of national and international missions. These missions are a testament to the efforts of many individuals who have worked to insure that worthwhile progress in the solar-terrestrial sciences would continue.

1.2 The Need for a Solar-Terrestrial Science Strategy Workshop

The Challenger accident has forced NASA and the space research community into a period of waiting and reappraisal. The most immediate effect of the accident has been the delay and then cancellation of a significant fraction of the shuttle flights planned to support solar-terrestrial science activities between 1986 and 1994. These included both manned science activities directly using the shuttle as well as unmanned satellites which were to have been launched with the shuttle. Decisions to cancel were based both upon the lack of flights available to solar-terrestrial science and because the cost to delay some flight investigations was prohibitive. New guidelines direct that the scarce resources offered by the shuttle should be employed for scientific research which is best served by the shuttle resources. This has led to an emphasis upon materials and life science research, at least in the near term out to 1994 in current NASA Office of Space Science and Applications (OSSA) Plans.

Looming in the future are possibilities for solar-terrestrial space investigations which take advantage of various space platforms related to the needs and plans of manned space flight. Possibilities include large, serviceable platforms such as the Earth Observation System in polar orbit, the Industrial Space Facility class of intermediate pressurized spacecraft capable of mounting external, attached instruments; and the much larger US/International Space Station (now known as the Freedom Space Station) with its full range of externally attached payload support facilities. There has also been increasing appreciation of the advantages of cooperative ventures with the Soviets and their Mir (Peace) space complex.

For the most part, the future flight plans developed within the Space Physics Division of OSSA have evolved without the use of space stations or large space platforms. As the plans of NASA's Office of Space Station matured, and political and funding support for this project appeared in Congress, it became increasingly clear that there was a need to evaluate the role such platforms could play in the future of solar-terrestrial science. Furthermore, in the light of the recent report from the National Academy of Sciences outlining space science goals for the 21st century, there is a need for creative thinking about far future programs exploiting the anticipated knowledge from the near-term flight programs of Table 1. In the current framework of the OSSA Space Physics Division, these far future missions exist within the realm of "in planning," and will require strong support from within NASA and the solar-terrestrial research community.

Another aspect of the future of solar-terrestrial science has evolved from the desire of the research community to participate in collaborative, international programs of research. Examples of successful collaborative undertakings in the past abound and the near-term missions listed in Table 1 are all the more valuable to the extent that they provide comprehensive views of solar-terrestrial phenomena. In recent months the European Space Agency (ESA), Canada, Japan, the Soviet Union, and the United States have engaged in various serious discussions about ways to promote international cooperation. All of the international participants in solar-terrestrial scientific research have plans for space flights that make important contributions to basic knowledge within the constitutive disciplines. These countries desire to develop formal relationships with the US for solar-terrestrial research.

1.3 The Decision to Organize a Solar-Terrestrial Sciences Strategy Panel Workshop

With this background, Dr. Stanley D. Shawhan, Director of the Space Physics Division at NASA Headquarters, decided it would be valuable for NASA to seek ideas and opinions about the future of solar-terrestrial science flight programs from active members of the research community. His desire was for a small group of experts to gather briefly to consider the long-range scientific needs of solar-terrestrial research in light of the opportunities offered by future flight programs. For the first time, these would include consideration of all types of space platforms, i.e., balloons, rockets, free-flying satellites, and the prospective variety of platforms supported by NASA's astronauts.

1.4 Participants in the STSS Workshop

Selection of individuals to serve as members for an ad hoc Solar-Terrestrial Sciences Strategy (STSS) Panel was made by Mr. W.T. Roberts (MSFC) and Prof. P.M. Banks (Stanford). The disciplines represented in the STSS Workshop were Solar Physics, Upper Atmospheric Science, Ionospheric Science, Magnetospheric Science, and Space Plasma Science. Twenty individuals were selected as official participants for the Workshop with approximately four persons assigned to each discipline. Table 2 provides the names of the panel members who attended the workshop meetings at Stanford University during the week of September 12 through 16, 1988. Other attendees who participated in the discussions are also listed.

Table 2. Attendees

Panelists	
Acton, Loren	Lockheed Corp.
Anderson, Hugh R.	Science Applications Int. Corp.
Baker, Daniel N.	NASA/GSFC
Banks, Peter M.	Stanford Univ., Chairman
Burch, James L.	Southwest Research Institute
Brueckner, Guenter	Naval Research Laboratory
Carignan, George R.	U. of Michigan
Chappell, C. Richard	NASA/MSFC
Chupp, Edward L.	U. of New Hampshire
Drobot, Adam	Science Applications Int. Corp.
Hastings, Daniel E.	Mass. Inst. of Technology
Hudson, Hugh S.	U of California, San Diego
Hudson, Robert D.	NASA/GSFC
Mende, Stephen B.	Lockheed Corp.
Nagy, Andrew F.	U. of Michigan
Raitt, W. John	Utah State University
Roberts, William T.	MSFC-PS02
Roble, Raymond G.	NCAR
Taylor, William W.L.	TRW Inc.
Walker, Arthur B.C.	Stanford University
Winningham, J. David	Southwest Research Institute
Speakers/Guests	
Balogh, Andre	Imperial College, London
Barfield, Joseph	Southwest Research Institute
Bartoe, John	NASA-Space Station
Benson, Robert	NASA/GSFC
Bonner, Thomas	Space Industries
Carter, David	NASA-SSU
Haskell, George	European Space Agency
Holemans, Jack	Wyle Laboratories
Jones, Vernon	NASA
Kendall, David	NRC Ottawa
Kropp, Jack L.	TRW Inc.
McEwen, D.J.	U. Saskatchewan
Parks, George	NASA-Code ES
Perry, Thomas	NASA-ES
Reeves, Edmond M.	NASA-EM
Sanders, Michael	Jet Propulsion Laboratory
Shawhan, Stanley D.	NASA-ES
Shepherd, Gordon	York U.-Canada
Vaughan, Arthur	Jet Propulsion Laboratory
Vondrak, Richard	Lockheed Corp.

1.5 Charter for the STSS Workshop

The workshop was presented with a charter for its activities by Dr. Shawhan. The overall goal of the workshop was to explore the future of solar-terrestrial science with emphasis upon those activities which would assume importance after 1995; i.e., after the major flight programs now regarded as being "Near Term" in Table 1 are in place and producing scientific information. Specific elements of the charter were to:

1. Establish the level of understanding to be accomplished with the completion of the current world-wide program of research in solar-terrestrial sciences
2. Identify the major questions to be answered by the future solar-terrestrial sciences research program as it might be if initiated within the next 10 years. An important input to this process was to be consideration of the National Academy of Sciences 21st Century report
3. Identify the space capabilities to be available to the future program and to provide input about the Space Physics Division's priorities for using these to accomplish its future scientific program
4. Map a program strategy to accomplish a future program of research in the solar-terrestrial sciences within the research community's perception of capabilities and constraints.

1.6 Organization of the Workshop

The STSS Workshop was organized with plenary sessions and discipline team meetings. The agenda for the workshop is given in Appendix I.

The first two days of the workshop were devoted to presentations from various NASA and industry personnel. The intent was to inform the workshop participants about current and near-term space flight platforms. In addition, Dr. Shawhan presented a detailed discussion of the current status of operating and near-term solar-terrestrial science missions.

The final 3 days of the workshop were organized around discipline meetings punctuated by general discussions with the entire group. This provided an opportunity for the ideas of each discipline to be evaluated in the context of the interests of the other groups. A final wrap-up session presenting the major recommendations from each discipline was held on the last day of the workshop.

1.7 Organization of the STSS Report

This report is organized along the lines of the discipline reports. Chapter 2 discusses the essential tools for solar-terrestrial sciences while the succeeding six chapters provide the results of the upper atmospheric sciences, ionospheric sciences, magnetospheric sciences, solar physics, and space plasma science, respectively. Chapter 8 contains a short discussion of issues brought forward by panel members during the discussions, but which belong in the category of general concerns rather than the specific plans or goals of the disciplines. Final recommendations of the workshop are given in Chapter 9.